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## THE NASAL PASSAGES OF THE FLORIDA ALLIGATOR.

BY ALBERT M. REESE, PH.D.

The material upon which the following work was done was received by the writer from southern Georgia, about the first of August, whence it had been sent by express to Baltimore.<sup>1</sup> It consisted of about thirty eggs of *Alligator mississippiensis*, most of which contained embryos in an advanced stage of development. These embryos were fixed in Kleinberg's dilute picro-sulphuric mixture, giving a fair fixation, and were stained in borax carmine and Lyon's blue. Serial sections were cut through the head in transverse, horizontal and sagittal planes. Although the structure of the nasal cavity, even of so advanced an embryo, cannot be taken to represent that of the adult, there have been so few figures of this character published that the following account may be of interest.

As may be seen from Plate XXIV, figs. 1*a* and 1*b*, the embryo is in an advanced state of development, and already shows distinct reptilian characters. The first series of sections (figs. 2*a-l*) was cut at right angles to the long axis of the snout of the embryo (fig. 1*b*, *x-y*), or rather it was intended to be an exactly transverse series but, by faulty orientation, the sections were so cut that the right side is inclined, somewhat, toward the base of the snout. This departure from the exact transverse position is the cause of the lack of symmetry in the two sides of the nasal cavity, as seen in this series of sections. Fig. 2*a* represents a section through the tip of the upper jaw. On the left it passes through the extreme edge of the wall of the nasal cavity, while on the right side, which is nearer the base of the snout, it cuts through the right nasal aperture, *r.n.a.* Near the centre of the section is seen the extreme tip of the nasal cartilage, *n.c.* The body wall, *b.w.*, in this section, as in all following sections, is represented by a heavy black line.

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Fig. 2*b* is somewhat further from the tip of the snout and cuts through the extreme point of the lower jaw, *l.j.* On either side of the large, median, nasal cartilage, *n.c.*, is seen the nasal canal, *l.n.c.* and *r.n.c.* On the left, the canal is, at this point, somewhat circular in cross section, while on the right, which, it will be remembered, is nearer to the base of the snout, the canal is more elongated in a dorso-ventral direction. The walls of the nasal passages are lined with cilia, and are, in most places, many cells thick. On account of the low magnification used, no attempt has been made to represent the cilia and cell outlines in these figures. The collections of cells, *t.r.*, in this and the following sections are the rudiments of the teeth. At the point represented in fig. 2*c*, the nasal cartilage, *n.c.*, has increased considerably in extent and almost completely surrounds the nasal passages on each side. In this and the following two sections, the plate of cartilage, *b.*, which lies ventral to the nasal passage on each side, seems no longer to be continuous with the vertical septum, *s.*, as in the preceding figure, although it is still in close contact with it. The nasal canals are drawn out, in this section, in a ventro-lateral direction, until their passages are reduced to mere slits. The passage on the right is drawn out, laterally, toward a small group of cells, *r.n.g.*, the apparent rudiment of one of the nasal glands. The teeth rudiments, *t.r.*, are seen in both upper and lower jaws, in the former of which they are very large, in proportion to the size of the jaw. The cartilages of the lower jaw are seen on each side, *m.c.*

In fig. 2*d* the nasal canals are still more closely invested by the nasal cartilages. On the right, the section passes through the opening of the right nasal gland, *r.n.g.*, into the nasal passage of the corresponding side. On the left side of the section is seen the left nasal gland, *l.n.g.*, cut in front of its opening into the nasal passage, that is, between this opening and the tip of the snout. In all the following figures *anterior* will mean toward the tip of the snout, *posterior* will mean toward the base of the snout or of the head.

Fig. 2*e* is a short distance posterior to the last figure. On the right it passes through the extreme anterior edge of the right eye, *e.*, while on the left the section is anterior to the eye. The nasal cartilage, *n.c.*, on the right, completely encloses the nasal passage

of that side, and thus lies between that passage and its nasal gland. The section is cut posterior to the opening of the right nasal gland, *r.n.g.*, into the right nasal passage, *r.n.c.* The left side of the section passes through the opening of the left nasal gland, *l.n.g.*, into the left nasal passage.

In the next section (fig. 2*f*) the complexity of the nasal apparatus has, apparently, considerably increased. In the first place, the ventral portions of the nasal cartilage, which, anterior to this point, formed a more or less complete wall ventral to the nasal passages, have disappeared, and on the right the dorsal portion of the cartilage has separated from the median, *s.*, and is now represented by a short straight piece, *n.c'*, and a long curved piece, *n.c.*, enclosing a part, *c.*, of the right nasal passage. On the left the dorsal wall of cartilage is still connected with the median septum. The nasal passages are here of quite different shape from what they were in the preceding section. They are still more elongated in a dorso-ventral direction, and that on the right, which is nearer the base of the snout, is cut at the point, *v.p.*, at which it opens ventrally into the narrow ventral passage, which, in turn, leads posteriorly to open at the posterior nares. *d.* represents a narrow diverticulum, projecting in a ventro-lateral direction, which may be followed almost to the posterior end of the large dorsal passage. A large branch of the main nasal passage, *r.n.c.*, is represented at *c.*, and the following section passes through the point at which this lateral passage opens ventrally into the main passage.

On the left side of the section is seen the left nasal gland, *l.n.g.*, cut posterior to its opening into the left nasal passage. On either side of the ventral end of the median cartilage, *s.*, is seen a small collection of cells, *j.*, which, according to R  se, is the rudimentary Jacobson's organ. These two collections of cells, which will be spoken of as "Jacobson's organ," extend from this point posteriorly for a considerable distance, as two solid rods of cells; they then become hollowed out to form tubes, which soon open ventrally into the ventral nasal passages, *v.p.*, as will be shown in one of the following figures. The section represented in fig. 2*f* passes near the extreme anterior end of Jacobson's organ.

In fig. 2*g*, which is only a short distance posterior to the one just described, Jacobson's organ is still seen as two solid rods of

cells. On the right, the ventral nasal passage, *v.p.*, is cut posterior to its opening into the main nasal passage and is hence seen as an independent, circular passage. On the left, the section passes through the opening of the left ventral passage, *v.p'*., into its adjacent main nasal passage. The ventro-lateral diverticula, *d.* and *d'*., are seen on either side. The right side of the section passes through the opening of the cavity *c.* into the ventral part of the right nasal passage, *r.n.c.*, while on the left the corresponding cavity, *c'*., is cut anterior to its opening and is surrounded on all sides by the nasal cartilage. In the preceding section the cavity *c.* was cut posterior to the region at which it was completely surrounded by cartilage.

In fig. 2*h* the nasal cartilages have about the same outline as in the figure just described, the sections represented by these two figures being close together. Jacobson's organ, *j.*, has increased somewhat in size, but there is still no trace of a cavity in either part. Both ventral nasal tubes, *v.p.*, are now entirely distinct from the main nasal cavities and are somewhat circular tubes lined with columnar cells. On the left the side cavity, *c'*., is still surrounded by cartilage, being again cut anterior to its opening into the left nasal passage, *l.n.c.*, while on the right of the section, at the point *c.*, the side cavity is seen to open dorsally into the main nasal cavity. The relation of this side cavity to the main nasal cavity is made plain by reference to fig. 3*a*, which represents a section cut in the plane *a-b*, fig. 1*b*. The section passed through the dorsal part of the nasal cavities, cutting the cavity on the right so far dorsally that but little indication of the side cavity, *c.*, is evident. It is plain, from this figure, that what has been called a side cavity, *c'*., is merely the posterior end of the main nasal cavity which has bent around until it projected outward and forward, and thus gave the idea, in transverse section, of a distinct offshoot from the main nasal cavity, *l.n.c.* Fig. 3*a* shows how the nasal cartilage, *n.c.*, pushes in between the cavity *c'* and the main cavity, *l.n.c.*, giving the impression, in transverse section, that the cavity *c'* is completely surrounded by cartilage. In a section ventral to this one, what has been called the main nasal cavity, *l.n.c.*, is seen to extend somewhat further toward the brain, *br.*, and in that way the cavity *c'*. is made to appear more like a branch of the main cavity than simply a forward

bending of the larger cavity. This posterior extension of the main nasal cavity is shown in fig. 2i, *l.n.c.* Fig. 3a shows that the median nasal cartilage, *s.*, extends back between the eyes, and becomes continuous with the cartilage surrounding the brain. It is somewhat swollen at a point about half-way between the nasal cavities and the brain.

The section represented in fig. 2i passes through the extreme posterior part of the main nasal cavities, *l.n.c.* and *r.n.c.*, and cuts the ventral canals, *v.p.*, posterior to the point at which Jacobson's organ opens into them. The way in which this takes place will be described later. The lateral parts, *n.c.*, of the nasal cartilages have diminished considerably in size, and now lie much nearer to the median cartilage, *s.* This section passes through the anterior ends of the two olfactory lobes, *o.l.*

In fig. 2j is represented a section cut posterior to the nasal cavity, so that neither of the main or dorsal nasal chambers are seen. The ventral passages, *v.p.*, have about the same size and position as in the preceding figure, while the lateral cartilages, *n.c.*, are reduced to mere rods, lying close against but not fused with the median cartilage, *s.* A short distance posterior to this point these cartilages end.

The section seen in fig. 2k is some distance posterior to the one just described, and shows how the ventral canals, *v.p.*, unite to form a single median canal, before they open posteriorly as the posterior nares.

This section does not cut the lateral parts of the nasal cartilage, but the median septum, *s.*, is seen extending dorsally, *b.c.*, on either side of the olfactory lobes, *o.l.* The outlines of the muscles of the eyes are shown in this as well as in the following figure by dotted lines, *m.*

Fig. 2l is somewhat posterior to fig. 2k, and passes through the opening of the ventral passages, the posterior nares, *p.n.* The other points brought out in this figure are about the same as in fig. 2k, and need no further description.

Fig. 4a represents, under a much higher magnification, a part of one of the sections of the series that has just been described. The ventral end of the median cartilaginous septum is shown at *s.*, and the ventral ends of the right and left nasal passages are seen at *r.n.c.* and *l.n.c.* The walls of these passages are made up of

one or more layers of cubical or columnar ciliated cells. The ventral passages, *v.p.*, are lined with similar cells, except that no cilia could be made out. On the left is seen, dorsal to the left ventral passage, the tubular organ of Jacobson, *j.*, which is cut anterior to its opening into the ventral passage, *v.p.*; its cavity is small, in cross section, and only extends for a short distance anteriorly, the greater part of the organ being a solid rod of cells without any visible cavity. On the right side of the figure, which, it will be remembered, is posterior to the plane of the left side, is seen the opening of Jacobson's organ, *j.*, into the right ventral canal, *v.p.* The united cavities of the ventral canal and Jacobson's organ have a sharply triangular outline, which is maintained for a considerable distance posterior to the point at which they first come together. The walls of the organ are of about the same structure as those of the ventral passages. For the sake of simplicity the mesoblast cells in this and in all of the preceding sections have not been represented. They are typical mesoblast cells and surround numerous blood vessels.

Fig. 5*a* represents a sagittal section of an embryo of the same stage of development as the one represented in fig. 1*a*. The section is nearly, but not exactly, in the median plane, so that some of the organs are cut medianally while others are cut to one side of the median plane. The general outline of the head is well shown and the relative positions of the main regions can be seen. The brain, *br.*, and spinal cord, *s.c.*, are represented in the heavier shading; the cartilaginous parts, including the vertebral column, *v.c.*, in the lighter areas. The great size of the nasal cavity is due to the fact that the section passes through one of the main nasal passages in the plane of its greatest diameter, fig. 2*f*. The other parts of the head will be easily understood by reference to the letters. As in the previous sections, the mesoblast has been omitted for convenience and simplicity.

#### LETTERING OF FIGURES.

*b.*—Basal plate of cartilage.  
*b.c.*—Cartilage around the brain.  
*br.*—Brain.  
*b.w.*—Body wall.  
*c.*—Lateral part of nasal canal.  
*d.*—Diverticulum of nasal canal.  
*e.*—Eye.

*h.*—Hypophysis.  
*j.*—Jacobson's organ.  
*l.*—Lens.  
*l.j.*—Lower jaw.  
*l.n.c.*—Left nasal canal.  
*l.n.g.*—Left nasal gland.  
*m.*—Muscle of the eye.

*m.c.*—Cartilage of lower jaw  
*n.c.*—Nasal cartilage.  
*o.*—Esophagus.  
*o l.*—Olfactory lobes.  
*p.n.*—Posterior nares.  
*r.n.a.*—Right nasal aperture.  
*r.n.c.*—Right nasal canal.  
*r.n.g.*—Right nasal gland.  
*s.*—Nasal septum.

*s.c.*—Spinal cord.  
*t.*—Tongue.  
*ta.*—Trachea.  
*t.r.*—Tooth rudiment.  
*v.c.*—Vertebral column.  
*v.p.*—Ventral passage.  
*x.*—Septum projecting back between main nasal canal and its side branch.

## EXPLANATION OF PLATE XXIV.

(All sections were drawn with a Zeiss Camera.)

Fig. 1*a*.—Side view, from a photograph, of an embryo of the stage represented in the sections. The yolk is not represented, but the cut stalk may be seen projecting from the abdominal wall just anterior to the hind legs (mag.  $\frac{1}{2}$  diam.).

Fig. 1*b*.—This is merely an outline drawing of the preceding figure to show the planes of the sections represented in the following figures.

Fig. 2*a*.—Transverse section through the tip of the snout. The section is so near the tip of the snout, that it does not cut the lower jaw (mag. 4 diam.).

Fig. 2*b*.—Transverse section posterior to fig. 1*a*. It passes through the extreme tip of the lower jaw (mag. 4 diam.).

Fig. 2*c*.—Transverse section still further toward the base of the snout. The details of the figure will be understood from the lettering (mag. 4 diam.).

Fig. 2*d*.—Transverse section posterior to the preceding (mag. 4 diam.).

Figs. 2*l* to *h*.—Transverse sections posterior to the preceding, passing through the right eye, but anterior to the left eye (mag. 4 diam.).

Fig. 2*i*.—Transverse section passing through the extreme posterior part of the main nasal passages (*l.n.c.* and *r.n.c.*). The section passes through the anterior edge of the left eye and through the anterior ends of the olfactory lobes (mag. 4 diam.).

Fig. 2*j*.—Transverse section just beyond the posterior end of the main nasal cavities. It passes through the extreme posterior ends of the lateral nasal cartilages (*n.c.*) (mag. 4 diam.).

Fig. 2*k*.—Transverse section through the point where the two ventral canals (*v.p.*) unite to form a single large median canal. The section passes through the eyes at about their central points, and shows the sets of muscles by which their motion is controlled. The lower jaw is cut at the point at which it becomes continuous with the neck, which accounts for the break in the ventral side of this and the following figure (mag. 4 diam.).

Fig. 2*l*.—Transverse section, a short distance posterior to the one immediately preceding, passing through the posterior nares (*p.n.*), and through the upper end of the trachea (*ta.*) which appears in the figure to be three distinct cavities (mag. 4 diam.).

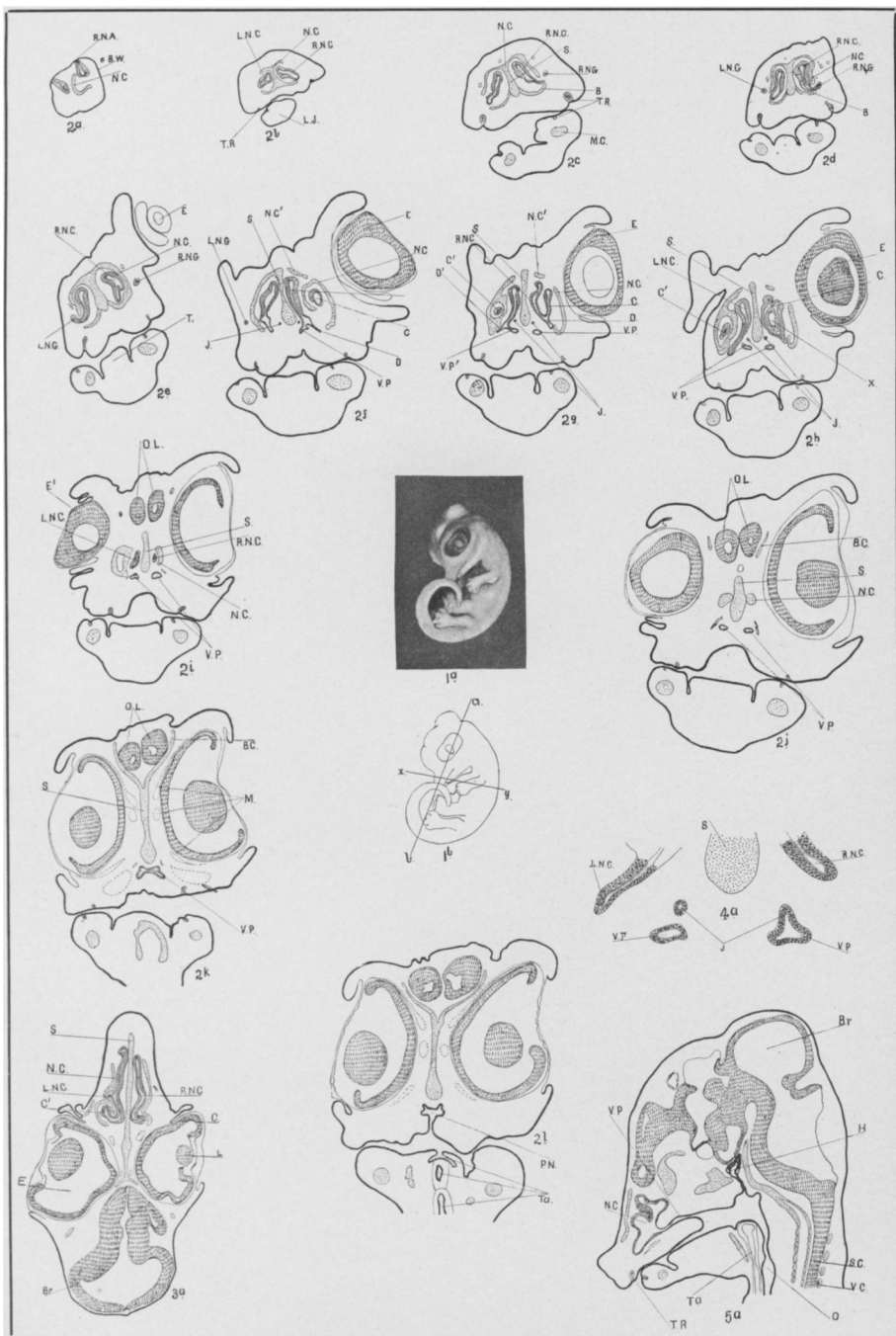
Fig. 3*a*.—Horizontal section through the plane *a-b*, fig. 1*b*. Shows the general anatomy of the head as seen in horizontal section, and especially the way in which the main nasal passages (*l.n.c.* and *r.n.c.*) curve outward and forward, as has been above described (mag. 4 diam.).

Fig. 4*a*.—Transverse section, under a much greater magnification, to show the structure and position of the paired Jacobson's organ (*j.*) (mag. 18 diam.).

Fig. 5a.—Sagittal section of the head of the embryo under consideration. The section is not exactly in a median plane, so that some of the unpaired organs are cut medianally while others are not (mag. 4 diam.).

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